Claims

1. Reconstruction method for reconstructing a first signal ($x(t)$) from a set of sampled values ($y_s[n]$, $y(nT)$) generated by sampling a second signal ($y(t)$) at a sub-Nyquist rate and at uniform intervals, comprising the step of retrieving from said set of sampled values a set of shifts (t_n, t_k) and weights (c_n, c_{nr}, c_k) with which said first signal ($x(t)$) can be reconstructed.

2. Reconstruction method according to claim 1, wherein said set of regularly spaced sampled values comprises at least 2K sampled values ($y_s[n]$, $y(nT)$),

wherein the class of said first signal ($x(t)$) is known,

wherein the bandwidth (B, $|\omega|$) of said first signal ($x(t)$) is higher than $\omega_m = \pi/T$, T being the sampling interval,

wherein the rate of innovation (ρ) of said first signal ($x(t)$) is finite,

wherein said first signal is faithfully reconstructed from said set of sampled values by solving a structured linear system depending on said known class of signal.

3. Reconstruction method according to claim 1, wherein the reconstructed signal ($x(t)$) is a faithful representation of the sampled signal ($y(t)$) or of a signal ($x_i(t)$) related to said sampled signal ($y(t)$) by a known transfer function ($\varphi(t)$).

4. Reconstruction method according to claim 3, wherein said transfer function ($\varphi(t)$) includes the transfer function of a measuring device (7, 9) used for acquiring

said second signal ($y(t)$) and/or of a transfer channel (5) over which said second signal ($y(t)$) has been transmitted.

5. Reconstruction method according to claim 1, wherein the reconstructed signal ($x(t)$) can be represented as a sequence of known functions ($\gamma(t)$) weighted by said weights (c_k) and shifted by said shifts (t_k).

6. Reconstruction method according to claim 1, wherein the sampling rate is at least equal to the rate of innovation (ρ) of said first signal ($x(t)$).

7. Reconstruction method according to claim 1, wherein a first system of equations is solved in order to retrieve said shifts (t_k) and a second system of equations is solved in order to retrieve said weights (c_k).

8. Reconstruction method according to claim 7, wherein the Fourier coefficients ($X[m]$) of said sample values ($y_s[n]$) are computed in order to define the values in said first system of equations.

9. Reconstruction method according to claim 1, including the following steps:

finding at least 2K spectral values ($X[m]$) of said first signal ($x(t)$),

using an annihilating filter for retrieving said arbitrary shifts (t_n, t_k) from said spectral values ($X[m]$).

10. Reconstruction method according to claim 1, wherein said first signal ($x(t)$) is a periodic signal with a finite rate of innovation (ρ).

11. Reconstruction method according to claim 10, wherein said first signal ($x(t)$) is a periodical piecewise polynomial signal, said reconstruction method including the

following steps:

finding 2K spectral values ($X[m]$) of said first signal ($x(t)$),

using an annihilating filter for finding a differentiated version ($x^{R+1}(t)$) of said first signal ($x(t)$) from said spectral values,

integrating said differentiated version to find said first signal.

12. Reconstruction method according to claim 10, wherein said first signal ($x(t)$) is a finite stream of weighted Dirac pulses ($x(t)=\sum_{k=0}^{K-1} c_k \delta(t-t_k)$), said reconstruction method including the following steps:

finding the roots of an interpolating filter to find the shifts (t_n, t_k) of said pulses,

solving a linear system to find the weights (amplitude coefficients) (c_n, c_k) of said pulses.

13. Reconstruction method according to claim 1, wherein said first signal ($x(t)$) is a finite length signal with a finite rate of innovation (r).

14. Reconstruction method according to claim 13, wherein said reconstructed signal ($x(t)$) is related to the sampled signal ($y(t)$) by a sinc transfer function ($\varphi(t)$).

15. Reconstruction method according to claim 13, wherein said reconstructed signal ($x(t)$) is related to the sampled signal ($y(t)$) by a Gaussian transfer function ($\varphi_\sigma(t)$).

16. Reconstruction method according to claim 1, wherein said first signal ($x(t)$) is an infinite length signal in which the rate of innovation (ρ, ρ_T) is locally finite, said reconstruction method comprising a plurality

of successive steps of reconstruction of successive intervals of said first signal ($x(t)$).

17. Reconstruction method according to claim 16, wherein said reconstructed signal ($x(t)$) is related to the sampled signal ($y(t)$) by a spline transfer function ($\varphi(t)$).

18. Reconstruction method according to claim 16, wherein said first signal ($x(t)$) is a bilevel signal.

19. Reconstruction method according to claim 16, wherein said first signal ($x(t)$) is a bilevel spline signal.

20. Reconstruction method according to claim 1, wherein said first signal ($x(t)$) is a CDMA or a Ultra-Wide Band signal.

21. Circuit for reconstructing a sampled signal ($x(t)$) by carrying out the method of claim 1.

22. Computer program product directly loadable into the internal memory of a digital processing system and comprising software code portions for performing the method of claim 1 when said product is run by said digital processing system.

23. Sampling method for sampling a first signal ($x(t)$), wherein said first signal ($x(t)$) can be represented over a finite time interval (τ) by the superposition of a finite number (K) of known functions ($\delta(t)$, $\gamma(t)$, $\gamma_r(t)$) delayed by arbitrary shifts (t_n, t_k) and weighted by arbitrary amplitude coefficients (c_n, c_k),

said method comprising the convolution of said first signal ($x(t)$) with a sampling kernel (($\phi(t)$, $\varphi(t)$) and using a regular sampling frequency (f, $1/T$),

said sampling kernel (($\phi(t)$, $\varphi(t)$) and said sampling frequency (f, 1/T) being chosen such that the sampled values ($y_s[n]$, $y(nT)$) completely specify said first signal ($x(t)$), allowing a perfect reconstruction of said first signal ($x(t)$),

characterized in that said sampling frequency (f, 1/T) is lower than the frequency given by the Shannon theorem, but greater than or equal to twice said finite number (K) divided by said finite time interval (τ).

24. Sampling method according to claim 23, wherein said first signal ($x(t)$) is not bandlimited, and wherein said sampling kernel ($\varphi(t)$) is chosen so that the number of non-zero sampled values is greater than 2K.